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Piezoelectric Transmitter

The present invention relates to a piezoelectric transmitter, like those that can be used as ultrasound transmitters.

The effects of ultrasound propagation, in particular sound velocity and sound dampening, are influenced by temperature. Furthermore, the piezoelectric constants of the piezoceramics very often employed as materials in the conversion of electro-mechanic energy in ultrasound transmitters are distinctly temperature dependent. In piezoceramic ultrasound transmitters, therefore the result is temperature-dependent acoustic transmission behavior.

Acoustic flow-through measuring devices and level detectors operating with ultrasound transmitters, therefore, usually require measuring the temperature prior to or during operation.
In many cases in the state of the art, an external temperature sensor measures the temperature. However, in this instance, in order to determine the temperature directly at the acoustic measuring point next to the acoustic transmitter, the external temperature sensor has to be guided to the measuring point, which requires additional cabling and complicated arrangements.

It is the object of the present invention to provide a piezoelectric transmitter that permits determining the temperature in a simple manner directly at the acoustic measuring point.

This object is solved with the features of the piezoelectric transmitter according to claim 1. Advantageous embodiments of the present invention are the subject matter of the subclaims.

A key element of the present invention is that the piezoelectric transmitter comprises a piezoelectric substrate, preferably a piezoceramic provided with a first electrode on a first surface and a second electrode on a second surface opposite the first surface. The first electrode does not cover the first surface completely. As a result, there is an electrode-free rim surface. This can be realized by selecting for the preferably circular electrode a diameter that is smaller than the diameter of the circular substrate surface. In this way, the diameter of the employed piezoelectric substrate is larger than the required radiating surface (aperture) of the piezoelectric transmitter. This aperture is determined approximately by an overlapping of the two opposite electrodes.

A component with temperature-dependent behavior is disposed respectively integrated on the electrode-free rim surface. One connection of this component is conductively connected to at least one of the two electrodes.

This type of piezoelectric transmitter construction permits determining the temperature directly at the acoustic measuring point via the temperature-dependent component. The integration of the component on the surface of the piezoelectric substrate guarantees uncomplicated temperature determination. Parallel or serial connection of the component to the capacitor formed by the two electrodes permits measuring the temperature directly via the two-pole leads for the electrodes. Therefore, no additional leads for the temperature sensor respectively the temperature-dependent component are needed, obviating expensive, complicated cabling.

Provision of connecting pads formed by the first and/or second electrode on a surface of the piezoelectric substrate permits realizing the integration of the temperature-dependent component by means of a simple connecting method (claims 3 and 4). No additional wiring is needed between the electrode or electrodes and the component. The invented piezoelectric transmitter can therefore be produced with little effort.

The present invention is made more apparent using a preferred embodiment with reference to the drawings. Shown is in:

Fig. 1 a rear view (a), a front view(b) and a side view (c) of an embodiment of an invented piezoceramic transmitter before placement of the component;

Fig. 2 the rear view of the transmitter from fig. 1 with the integrated component (here: temperature-dependent resistor);

Fig. 3 the transmitter from fig. 2 in a housing; and

Fig. 4 a basic circuit of the circuitry of the component with the capacitor formed by the two electrodes, as a parallel (a) or serial circuit (b).

Fig. 1 shows a side view, a rear view and a front view of an embodiment of an invented piezoceramic transmitter before it is provided with a temperature-dependent component. In the depicted embodiment, a circular, disk-shaped piezoceramic is employed as the substrate (1). An also circular electrode (2) (except for noses 4,5) whose diameter is smaller than that of the piezoelectric ceramic is disposed on the rear side of the ceramic (see fig.1(a)).

As the size of the electrode determines the radiating surface of the transmitter, in the present case a piezoceramic is therefore employed whose diameter is larger than the radiating surface (aperture) of the transmitter required for the intended application.

Due to the different diameters of the piezoceramic and the rearward electrode, there is an electrode-free rim surface (3) on the rear-side surface of the ceramic. The rearward electrode is also provided with two noses (4,5) which extend into the electrode-free rim. These noses form connecting pads for the subsequent contacting of the electrode to a supply lead (nose 4) and to the component having the temperature-dependent behavior (nose 5).

In the front view (b) of fig. 1 it can be seen that in the present embodiment the front electrode (6) extends over the entire front surface of the piezoceramic. This front electrode is also provided with two noses (7,8) running around the rim of the disk-shaped piezoceramic to form two connecting pads (7,8) in the electrode-free rim area (3) on the rear side. These two connecting pads, like the rear-side electrode (2), are provided with a supply lead (nose 7) and the component (nose 8) for contacting the front electrode.

Partial picture (c) shows a sectional view through the line A-A′ in the partial picture (a). One can see here the piezoelectric ceramic (1), the rearward electrode (2) and the front electrode (6) with the nose (8) running around the rim of the piezoceramic to form a connecting pad on the opposite surface. In picture (c) of fig. 1, for clarity the electrodes are drawn at a distance from the piezoceramic. Actually, however, they are in contact with the piezo-ceramic.

Conventional materials such as lead zirconium titanate (PZT)can be employed as materials for the piezoceramic material. Preferably silver, gold or nickel are used as the electrode materials. Typical dimensions of the piezoceramic are a thickness ranging from 1 to 4 with a diameter ranging from approximately 10 - 30 mm.

Fig. 2 shows the preferred embodiment of fig. 1 with an integrated temperature-dependent resistor (9) and disposed supply leads (10) to the electrodes. The circuit of the temperature-dependent resistor to the capacitor formed by the two electrodes corresponds, in the present embodiment, to a parallel circuit as shown in the diagram in fig. 4(a). The leads can, for example, be soldered to the connecting pads. (4,7).

In the invented embodiment of the piezoceramic transmitter, advantageously the piezoceramic is simultaneously utilized

as a board. The connecting pads that are formed by the electrodes themselves permit realization of a very simple connecting method with minimum cabling.

A transmitter of this type can, for example, be used to measure the level of gas bottles from the outside.

The temperature-dependent resistor can, for example, be a PTC or a NTC resistor. Another type of temperature sensor that should preferably be built in the SMD manner is also possible.

Fig. 3 shows a side view of an invented transmitter having a coupling layer (12) and an integrated temperature-dependent resistor (for example SMD-NTC(9)) in a housing (11). The connecting cables (10) are also shown.

Fig. 4 shows the two circuit variants integrated in the component. To be noted in realizing the parallel circuit as depicted in fig. 4a (and in fig. 2) is that the electric resistor of the component (here a temperature-dependent resistor) only minimally dampens the high-frequency ultrasound wanted signal for triggering the electrodes. In this case, for example, a high impedance NTC resistor should be employed in conjunction with a low impedance ceramic. For example, in realizing a 1.5 MHz transmitter which has an impedance of approximately 50 Ω (preferably the minimum impedance at this frequency), a NTC resistor with a resistance of at least 10 to 20 kΩ can be used.

In realizing a serial circuit as shown in fig. 4b, a low impedance PTC resistor should be employed in the serial circuit with a high impedance piezoceramic.

The depicted parallel circuit respectively serial circuit permits transmitting the temperature data with its low-frequency signal behavior over the same two-pole supply lead (10) that is also used for the high-frequency ultrasound data, thereby obviating the provision of additional supply leads. In particular, this simplified arrangement permits distinctly simplifying installation when using the transmitter.

The invented arrangement of the electrodes in conjunction with the provision of a piezoceramic whose diameter is larger than the needed radiating surface offers a very simple method of connecting the component to the electrodes by means of integrated connecting pads.

Of course, the shape and the precise dimensions of the piezoceramic and the electrodes depends on the respective application and are not limited in any manner in scope or spirit by the teaching of the present invention. Other

integratable components can be employed to determine the temperature instead of temperature-dependent resistors.